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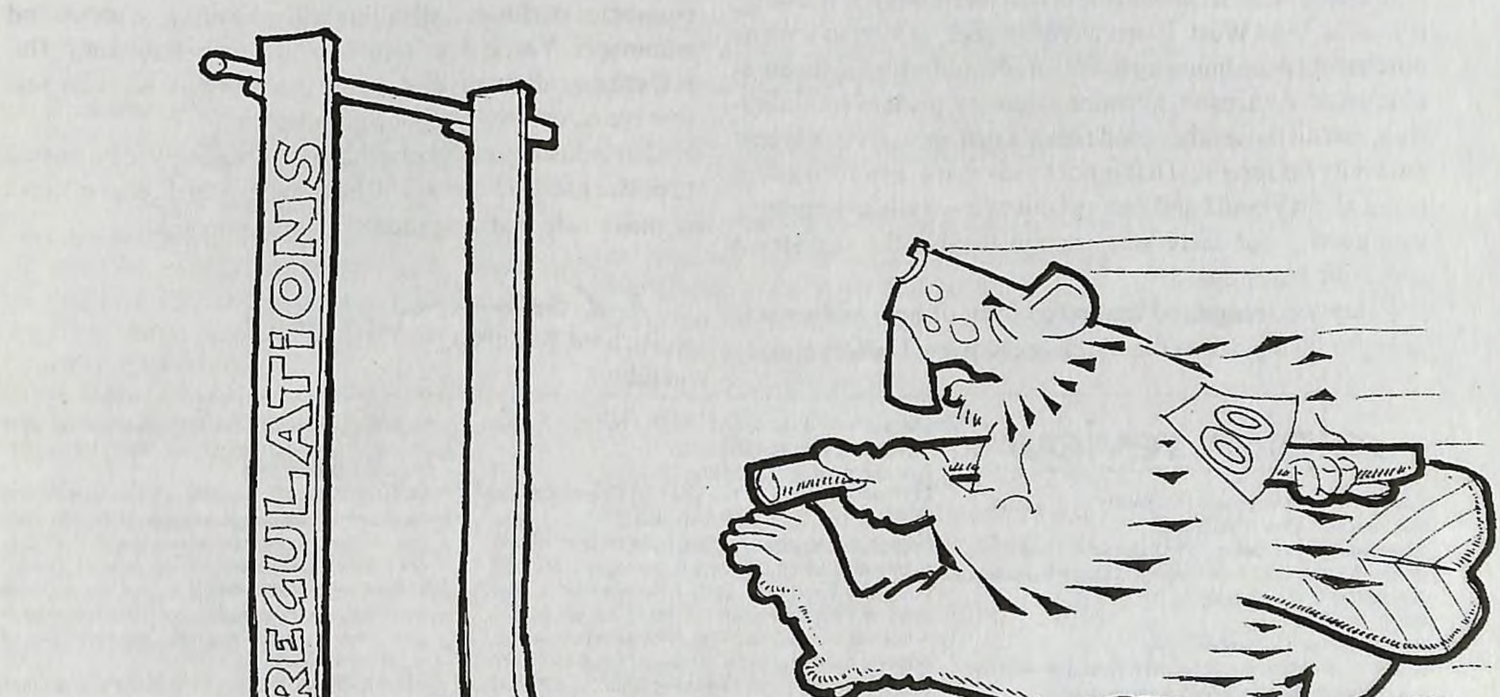

From the Editor . . .

It is part of human nature to be afraid of change. When change is the result of our activity, but we are not in full control, the fear seems to intensify.

What does a discussion about fear of change have to do with the building industry? Fear of change is something we encounter regularly when facing a NIMBY situation. For example, residents expressing their fear about the face of their neighbourhood when new development is about to take place. Any change to the status quo is a cause of concern and so is feared. Look what happens every time a regulation is changed in some way. Someone always expresses concern even when the change is a result of broad-based consultations (as happens with regular building code reviews).

I started thinking about this fear of change when observing the reaction to the significant changes that are about to be introduced to the construction sector in BC. Everyone knows that something has to be done in the wake of the failure of the entire development system in BC over the past few years (this is also known as the leaky condo fiasco).

Up to now, the construction marketplace has been relatively free and unfettered. Although some believe that development controls and fees may have been excessive over-regulation, when it came to the bricks and mortar of building, it was the Wild West. It was anything goes, at least as long as purchasers were lining up to buy products dressed in fashionable decor. As a result, attention to quality, pride of workmanship, and all those other good phrases that we use, were at best paid only lip service. That is not to say that everyone was out to get all they could and then get out of town while the getting was good - but there was enough to give the industry a collective black eye.

Everyone recognized that some form of intervention was going to take place in the building industry. Unlike so many studies by commissions which are simply used merely to defuse a charged situation and then allowed to gather dust, the BC government has introduced legislation to carry out the changes recommended by a commission of enquiry. This is happening with startling speed, after the commission did a surprisingly neutral analysis of the situation. All the key players have grudgingly admitted as much. I say "surprisingly neutral" due to the immense political pressure on the government to do something because so many low income owners were caught up in the problems. In addition, the commissioner in charge was not a judge or technocrat, but a former premier of the province.

Now that action is being taken, I hear people in the building industry vehemently denounce the government for introducing the legislation, for taking action, for introducing another bureaucracy, and so on. In other words, many of the same words we disapprove of as just more NIMBY baffle gab. I suspect that, politics aside, much of the anxiety is simply fear of change.

No longer will it be possible to walk up to a municipal counter in any BC town, lay down a few dollars and collect a business license declaring oneself to be a contractor. From now on, there will be a screening process before a contractor licence is issued. There will also be more vigorous enforcement, and mandatory third party warranties on all work a contractor performs. All of this will take effort to set up and administer. Yes, it does seem like another bureaucracy. But is there any alternative? After all that has gone on in the last few years, can we really be surprised?

Our industry just does not have the credibility to be trusted to police itself. The trust will have to be earned. We will have to make sure that we practice what we preach.

Richard Kadulski,
Editor

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Regulatory Obstacles to Innovation in Housing Design

The housing industry is one of the most regulated sectors of society. Activity is governed by many rules, regulations and laws that have developed over a long time, usually as a reaction to some event or social pressure.

Innovators often encounter regulatory obstacles when building innovative demonstration housing. These obstacles can add significantly to a project's cost, both in terms of time and money. Sometimes the obstacles may discourage attempts to implement new, environmentally sound, healthy housing.

In recent years, we have seen a number of innovative housing projects in Canada. The Advanced Houses, CMHC's Healthy Houses initiative, and numerous independent projects that have been built on the foundations of earlier innovative developments over the past fifty years,have encountered some regulatory obstacles, both technical and institutional in nature. The extent of the obstacles encountered have been documented in a recent CMHC study that reviewed a number of innovative projects undertaken between 1992 and 1997.

CMHC defines healthy housing, in its broadest sense, as an approach to sustainable design that addresses:

1) occupant health;
2) energy efficiency;
3) resource efficiency;
4) environmental responsibility; and
5) affordability and economic viability.

This inclusive approach to environmental, social and economic responsibility in housing calls for innovation and is, arguably, the most important challenge facing policy-makers, municipal authorities, design professionals and the building industry today.

In most jurisdictions, new concepts such as healthy housing were simply not considered when the regulations were developed. In the absence of specific policy directives or regulations addressing innovations, administrators feel they must treat innovative applications the same as conventional ones. In addition, local governments generally lack explicit legislated powers to address broad environmental issues.

Biases of the regulators, personality conflicts and the reputation of the applicant, often complicate institutional code issues, making them more difficult to overcome. The threat of legal liability typically reinforces regulatory obstacles.

More education and training is needed for building officials, especially in the principles of healthy housing.

Polls and other indicators show that the environment is high on the public's list of concerns. However, professionals and decision-makers remain unclear how to incorporate these new values into land-use policies and building codes and how to implement them in the form of coordinated regulations.

Out of frustration, Martin Liefhebber, architect of the Toronto Healthy House, suggests that "bureaucratic change, not technology has to be the next advance."

Land Use and Planning

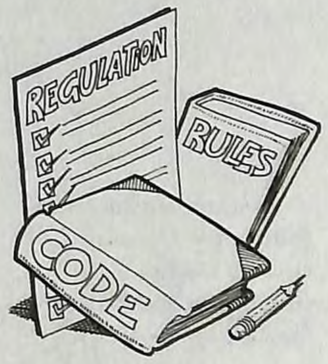
Public opinion is a potent force that may affect zoning changes or city policies. Neighbourhood opinion may become a de facto regulatory obstacle. Local groups may oppose healthy houses with unusual land-use approaches or unusual exterior appearance.

There may be substantial NIMBY (Not In My Back Yard) response to innovation, to which planning staff and elected officials must respond, even when the innovative proposal is consistent with long-term planning goals.

Engineering and Development Standards

Local governments administer standards for site servicing. These standards are based on assumptions about water consumption, waste generation and vehicle use that are sometimes very outdated and out of touch with recent trends.

There is growing interest in applying sustainable design principles to the development of whole communities, and these challenge the existing civil engineering standards. Just a few examples are narrower roads and smaller storm, sanitary and water systems (or local water sources, such as rainwater cisterns), as well as local stormwater that is managed by absorption areas.



Building Codes

Code issues in building innovation typically include the use of unusual materials, components and energy, water and waste management systems.

Innovative structural systems and materials

may not conform precisely to some structural, life safety or fire safety aspects of codes, usually because they have not been tested and proven to the satisfaction of code committees. Even if a material or detail has great environmental merit and is well justified by building science and engineering, unless it is recognized and listed, it does not meet code requirements.

Convincing code authorities that these innovations are satisfactory for their proposed use can be difficult, even though nearly all codes contain equivalence and performance clauses that allow a case to be made for alternative approaches.

However, the building code is less of a barrier to innovation than lobby groups with vested interests that keep construction practices and standards as they currently are.

Fire Codes

It would not have been possible to construct the Toronto Healthy House "off-the-grid" if a sprinkler bylaw had applied to duplexes in that city, because a municipal water service is required to supply adequate water pressure and volume for sprinklers.

In the Vancouver Healthy House, an infill unit, fire authorities initially wanted both adjoining buildings (not part of the project) to be sprinkled. In addition, authorities objected because the unit did not have a street-front presence.

Plumbing, Gas and Electrical Codes

Innovative housing often involves unusual plumbing, mechanical and electrical systems to deal with water, energy conservation or air quality concerns. This area also involves health authorities and is often the most difficult to penetrate with new approaches due to potential health concerns. Health authorities are usually resistant to new technologies.

New guidelines and protocols for acceptance of on-site water and sewage systems should be developed.

Other Non-Code Obstacles

Lenders and mortgage insurers create obstacles for some innovative buildings. In one case, a house was super-insulated and shown to be capable of maintaining comfortable indoor conditions in winter through solar gain and thermal storage, so the design did not include a furnace. However, the mortgage insurer rejected the idea, and insisted that a furnace be installed. A furnace was installed but has never been used.

Renewable energy systems invariably challenge power utility regulations. This makes it difficult to incorporate such systems into conventional utility grids.

Whether something works or is feasible is not important if no one will buy it. Here lies the greatest risk to the project. A few bold developers have attempted to build healthy houses on speculation for market sale, with mixed results.

Also needed are revised administrative procedures to ensure a greater consistency between plan checkers and field inspectors so that once an innovation has been accepted as part of the building permit process, it can be installed without need for further documentation and debate. There have been cases where approved plans were denied by the field inspector due to discomfort with or lack of understanding of the new technology proposed.

Factors affecting the success of an innovative housing project include:

Personal style:

Applicants may make things harder for themselves if they approach regulatory officials with the belief that being innovators makes them exempt from code requirements. They can also complicate matters if they install components before receiving permits, or are inflexible on small points of compliance. That wastes money and creates the impression the applicant is trying to "get around" the inspection and approval system.

Regulatory staff who support innovative proposals philosophically can smooth the way for applicants and prevent applications from stalling in the approval process. However, innovative designers should never assume that they are immune from existing regulations. Applicants must work within the existing regulations, and if they are proposing alternative approaches, they must be prepared to support the application with detailed information.

Choice of site:

Permitted and straightforward siting will avoid the need to seek variances and any site-related code difficulties.

Preliminary discussions:

Give building officials the opportunity to have input on the project before it begins. Discussing the design and its unusual elements prior to applying for permits can give the applicant time to learn about potentially problematic issues early in the design process, build a case, and establish credibility with those granting approvals.

Technical research and preparation:

Applicants anticipating that some of their design elements will not meet code must be well prepared with supportive documentation that can overcome liability worries if products have not undergone Canadian testing and approvals. Professional design and letters of assurance can help convince officials of product and project worthiness.

Building codes and regulations do not always inhibit innovation. In many instances, their provisions for acceptance of alternatives and equivalencies are successfully used. However, a quicker process for approving alternate interpretations to building code is needed. To facilitate demonstration and innovation, regulatory agencies may wish to consider two measures:

Materials acceptance: allow a limited waiver of material certification for research and development purposes.
Rewarding healthy housing: Recognize, encourage and reward environmentally appropriate developments through explicit statements in both local council policy and implementation bylaws. ☼

Regulatory Obstacles to Innovative Housing by Habitat Design & Consulting and Archemy Consulting for CMHC.

Mold Problems in Flood Areas

Molds are a major cause of health problems. Homes subject to flooding are especially vulnerable. The cost for the mold contamination, remediaton and renovation cycle is large. The question is, how effective is remedial work that is done to clean up flood damage?

A recently completed study for CMHC looked at a community in Manitoba that was affected by the Red River flood of 1997. The community was evacuated for four weeks, and although it was protected by a dike, some flooding did occur, mostly basement seepage below grade and some sewer backup. Some homes flood annually, but the flooding in 1997 was worse than in other years.

Although the basements were cleaned and, in some cases renovated, mold continues to be a problem. Of more than 114 homes that were flood damaged, at least 34 have been identified as contaminated with *Stachybotrys-atra*, a dangerous mould. At least 53 other homes have been identified as contaminated with various other molds.

Investigations confirmed that mold remediation undertaken is not effective and only provides a short term solution. Most of the recent renovations are best described as cosmetic and do nothing to resolve the underlying causes of recurring mold problems. Waterproofing, drainage and ventilation have been ignored. Remediation of the underlying causes of the mold growth is required. A detailed look at eight houses showed there was evidence of mold in all of them. New drywall, paint and tile floors made the living areas look clean but the extent of the visible mold in the one house where the walls were not covered at the time of inspections leads to the suspicion of similar mold covered up in other renovated houses.

Poor site drainage resulting in seepage into basements is the largest single factor contributing to the mold problems. Unless water entry is stopped, mold problems will continue. High water table areas and those subject to flooding create very difficult conditions in which to build houses with full basements. Basements are to be discouraged in such locations. In flood prone areas shallow crawlspace or slab on grade are preferred.

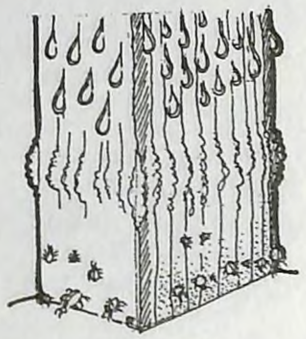
Factors Contributing to Mold and Other Indoor Air Quality Problems

Original Building Construction Techniques

The original construction techniques made the buildings susceptible to moisture and mold problems. Full depth basements are insulated and finished on the interior, and the drainage is inadequate. The interior insulation and finishing creates hidden cavities for mold growth making clean-up more difficult.

Any basement that has flooded in the past may very well flood again in the future, despite renovations designed to seal against water leakage and improve drainage. Thus, re-insulating previously flooded basements on the inside is strongly discouraged. Insulating on the outside will allow much easier remediation of any future flooding problems.

The foundation damp proofing and perimeter drainage are unknown but suspect. The likelihood of below grade water penetration is enhanced by eaves troughs without down spouts.



Poor detailing of the above grade envelope components and inadequate mechanical ventilation, along with inadequate maintenance, have all made the problems worse.

Other pollutants, particularly tobacco smoke, are also contributing to poor indoor air quality as the installed mechanical ventilation in all houses

is inadequate. The bathroom ceiling exhaust fans provide weak airflow. Ducting is suspect. Range hoods are often circulating rather than exhausting.

Renovation Strategies to Prevent Recurring Problems

Unless there is a dramatic shift in focus to deal with the underlying cause of moisture ingress, the current cycle of mold contamination, remediation and renovation should be expected to continue repeatedly, with no end in sight. With the right temperature conditions, and availability of food (almost anything organic), the mold will always return.

A new approach which solves, rather than covers up problems, and which provides more durable, energy efficient housing will be far less expensive and certainly far less stressful for the families involved, than repeated evacuation, mold remediation and renovation of houses which were not originally built to an appropriate standard.

Renovation work must keep the *house is a system* concept in mind. The building envelope, mechanical system and lifestyle of the occupants all affect each other.

For the building envelope, the key issues are:

- Stop water leaks
- Reduce cold surfaces which can lead to condensation and mold growth
- Gain more control over random air leakage, leading to more control over indoor air

For the ventilation and mechanical systems, the key concerns are:

- Manage the relative humidity
- Exhaust stale air
- Circulate the fresh air to all living spaces.

Options for Low-Cost Foundation Remediation

- Ensure that sump pits are fitted with sealed covers and basement floor drains with back flow prevention valves are installed, and that any pumps work as designed.
- Seal any holes in the foundation walls, wall cracks or floor cracks.
- Insulate the foundation on the exterior, from the top of the concrete wall to at least two feet below finished grade. When backfilling against the insulation, raise the finished grade enough to provide a slope away from the foundation.
- Install insulation and a sealed air/vapour barrier in the joist spaces along the inside face of the rim joist.

A Study of Recurring Mold Problems on the Rosseau River Reserve, Manitoba, by Boles Construction for CMHC.

Options for Higher Cost Foundation Remediation

Below grade:

- Excavate and waterproof the exterior of the foundation walls and install full height free draining exterior insulation.
- Install perimeter drainage if there is none.

Above Grade Building Envelope:

- Repair the roof and exterior finish if necessary.
- Tighten up the building envelope.

Ventilation and Mechanical Systems

- Ensure that existing bathroom ceiling exhaust fans are vented directly to the outside with sheet metal duct complete with sealed joints. Alternatively, upgrade existing fans with newer units that have a centrifugal blower, a sound rating of 1½ sones or less, and are capable of meeting the principal exhaust fan requirements of the National Building Code.
- Retrofit or upgrade the kitchen range hoods to ensure the unit exhausts directly outside.
- Ensure that heating supply ducts are connected or installed in every room.
- Undercut room doors by at least one inch if necessary or provide louvers through the doors to ensure good return air flow to the central returns of forced warm air heating systems.

Options for Higher Cost Ventilation

- Install a balanced heat recovery ventilation system integrated with an existing forced air heating system.
- Improved ventilation will not reduce humidity if the weather outside is warmer and more humid than it is inside. Cool basement surfaces are especially prone to condensation when warm, humid air is introduced in summer. During hot humid summer periods, the ventilation system may need to be kept shut off. ☼

Technical Research Committee News

Canadian Home Builders' Association

Carbon Monoxide Detectors Required by Toronto Bylaw

In March the City of Toronto passed a bylaw requiring all occupants of dwellings with fuel burning appliances to have a carbon monoxide (CO) detector installed and maintained according to manufacturers' instructions by Nov. 1, 1998.

For the purposes of the bylaw a fuel burning appliance means "appliances such as, but not limited to furnaces, refrigerators, clothes dryers, water heaters, boilers, fireplaces, wood stoves, charcoal grills, gas ranges, and space heater, which are fired by flammable fuels such as, but not limited to natural gas, propane, heating oil, kerosene, coal, wood and charcoal."

Fire Prevention Inspectors operating under the fire chief have been appointed "property standards officers" for the purposes of administrating and enforcing the bylaw.

HOT-2000 Version 8

The latest version of the program was officially released at the Energy Efficient Builders Association in Washington, DC last month. The technical basis of the program is substantially unchanged from the previous versions, except that it is now runs under Windows 95 or NT4.

Sales are being handled by CHBA. New users price is $295.00 plus applicable taxes, while upgrades for previous version users is $175.00 plus taxes before December 31, 1998.

Crawl Spaces: Avoiding Moisture and Soil Gas Problems

CMHC has prepared a short guide to crawl space construction. This publication gives builders background information that will help explain forces affecting this foundation type. It discusses basic moisture movement principles and how to avoid moisture problems. The booklet is timely, with the revised building code regulations affecting crawl spaces.

Ventilation of Houses

Requirements for ventilation in the National Building Code have been substantially changed in the latest edition. In the last issue we did a review of the new code provisions. The intent of the code is to lay out minimum standards that will provide a safe indoor environment for the occupants. However, we may have glossed over one aspect of depressurization requirements. Unfortunately, it is one case where the code provisions are questionable at best. The result is that a home meeting minimum code requirements could still have significant levels of combustion gas spillage. (This section was adopted into the BC Building Code, so the same concern applies in BC, although other ventilation provisions are different).

Where a solid fuel (i.e., wood) burning appliance is installed, and a carbon monoxide detector is installed on or near the ceiling of that room, then makeup air for large exhaust fans is not required.

Yet we know that exhaust fans can cause spillage of combustion products from combustion appliances if the house is depressurized. Appliances vulnerable to pressure-induced spillage are those that draw combustion air from the house, and are vented through a natural draft chimney. Examples include older gas furnaces and water heaters with a draft hood, oil furnaces with a barometric damper, open fireplaces and wood stoves, and any other appliance with a B vent. Appliances such as gas furnaces and water heaters with sealed venting systems and "sealed combustion" oil furnaces are resistant to spillage and do not require make-up air openings.

For some reason, the code requirements for depressurization limits apply to gas and oil combustion appliances, but not to wood stoves and fireplaces. This can have the consequence that a small electric baseboard-heated bungalow, with a wood stove and a large exhaust fan such as a downdraft cooktop, need not be equipped with makeup air for the large cooktop exhaust fan if a CO detector is installed near the wood stove. The results are that combustion gases and ashes could be sucked back into the house when the cooktop is turned on, with no code penalty.

It would be prudent for builders to ensure they do more than the absolute minimum, and ensure that they do not create conditions subject to the depressurization above acceptable limits. ☼

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.

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Renovator's Technical Guide

Modern houses are expected to provide a comfortable environment for their occupants. Fifty years ago, owners had lower expectations for their houses. Drafts, damp basements, uneven temperatures and other discomforts were common and widely tolerated. Heating systems were inefficient and, in Canadian houses, cooling systems were largely nonexistent.

Owners have also become more demanding of the aesthetic requirements of their home. As a result, renovations to existing older housing stock have become a bigger sector of construction. The challenge for renovators is that, unlike new construction, there are many potential problems and tasks, but not everything can be tackled on every job.

Over the last half century, we have gained a better understanding of how buildings function and perform. CMHC has drawn on this knowledge in their new Renovator's Technical Guide. This guide is not a how-to manual. It does not explain how to complete a renovation project. Rather, it is a diagnostic tool, focusing on why problems occur, how to avoid them and how to avoid creating new ones as you renovate a house.

The ten renovations discussed in this book are based on common types done across Canada. These include basement, kitchen, bathroom and attic space renovations, and also additions. Also discussed are changes to exterior and interior finishes, to doors and windows and to mechanical systems.

The renovator is expected to recognize building problems, decipher any symptoms, establish causes for problems and formulate solutions, often in a matter of minutes, while the homeowner looks on. The renovator acts like a detective trying to collect clues to solve a case. One who doesn't understand building science, risks creating building performance problems where none existed before.

Renovator's Technical Guide
Canada Mortgage & Housing Corp. $39.95

A good understanding of building science fundamentals includes an appreciation of how all of the building's systems, its components and materials function as a whole. The building science practitioner - a role renovators need to assume - uses many tools to identify and diagnose building performance problems and predict how any alterations made to the building will affect its performance.

For example, problems with the interior finishes of a home are usually linked to another faulty component or to a system in the building. Changes to mechanical systems affect the rest of the building while the effects of other renovations can affect existing mechanical systems.

Each chapter presents the material in terms of the five steps that will lead to a trouble-free renovation.

Observation. Seeing the defects is an important first step in any type of renovation. Other systems may be at the root of problems you find.

Diagnosis. Careful assessment can reveal whether the problem is ongoing or a one-time event. Assess the condition of the entire building at the beginning of the process, focusing on specific aspects related to the renovation. Although a complete and detailed assessment can be time consuming, it can uncover unanticipated problems that can play havoc with your renovation. In addition, it can often be used to alert the homeowner to necessary work that was not initially considered, increasing the value of the total project.

Solution formulation. Once a problem is diagnosed determine appropriate solutions.

Remedy the problem and causes. Before starting the renovation, or even confirming the contract, be sure that you completely understand your client's expectations.

Renovation. Only once all the ground work has been prepared, should you start the actual work.

Business skills

When preparing to do a renovation within an existing home, many administrative details need to be addressed.

Good communication before the project begins can prevent headaches and problems later.

The presentation of the material in the book is structured around a renovation checklist. It reviews common problem areas and room by room. We have presented a shortened version here. Each of these topics has several sub-points that are described in greater detail. ☼

Always follow the five steps to a successful renovation:

- ✔ *Observe defects carefully*
- ✔ *Diagnose the true cause of any problems*
- ✔ *Find appropriate solutions*
- ✔ *Remedy the problem and the cause*
- ✔ *Only then start the renovation work.*

Renovation Assesment Checklist

Foundation and Basement Renovations
- ❑ Foundation problems & construction techniques
- ❑ Concrete curing and shrinkage
- ❑ Backfilling practices
- ❑ Adfreezing and frost heave
- ❑ Foundation problems and soil bearing capacity
- ❑ Soil gases
- ❑ Insect infestation
- ❑ Water vapour problems
- ❑ Capillary water problems
- ❑ Bulk water problems

Renovating Kitchens and Bathrooms
- ❑ Design considerations
- ❑ Structural considerations
- ❑ Moisture damage
- ❑ Indoor air quality
- ❑ Plumbing problems
- ❑ Damaged materials or finishes

Replacing Windows and Doors
- ❑ Water damage
- ❑ Air leakage
- ❑ Structural support
- ❑ Other problems

Renovating Interior Finishes
- ❑ Water damage
- ❑ Structural support
- ❑ Construction techniques
- ❑ Durability of materials

Repairing and Replacing Exterior Finishes
- ❑ Poor rain & snow-shedding on roof
- ❑ Poor rain & snow-shedding on walls
- ❑ Indirect causes of finish distress
  - ❑ Structural or attachment deficiency
  - ❑ Adfreezing or frost heave
  - ❑ Inadequate damp proofing or rain diversion system
  - ❑ Grading
- ❑ Other deficiencies

Attic Conversions
- ❑ Structural damage & foundation support
- ❑ Water damage
- ❑ Air and vapour protection
- ❑ Attic ventilation
- ❑ Services

New Additions
- ❑ Design, approvals and permits
- ❑ Site and foundation conditions
- ❑ Existing structural conditions
- ❑ Services

Renovations and Mechanical Systems
- ❑ Discomfort
- ❑ Poor envelope construction
- ❑ High energy bills
- ❑ Poor maintenance
- ❑ Faulty equipment
- ❑ Gas furnaces
- ❑ Oil furnaces
- ❑ Hydronic systems
- ❑ Water heaters
- ❑ Heat pumps
- ❑ Air conditioners
- ❑ Ventilation
- ❑ Chimneys

Energy Efficient Retrofits
- ❑ Air sealing
- ❑ Insulation
- ❑ Windows and doors
- ❑ Mechanical systems
- ❑ Space heating and cooling systems
- ❑ Ventilation
- ❑ Domestic hot water heating
- ❑ Other Factors
- ❑ Lighting
- ❑ Controls
- ❑ Appliances
- ❑ Lifestyle choices

Adapted from *Renovator's Technical Guide*, CMHC, 1998

Healthy Housing and Passive Solar Design

Modern heating and cooling systems have enabled us to create comfortable interior spaces, no matter what climate and building envelope design. Despite enormous regional differences in climate across this country, it is the similarity of our buildings, not their differences, which is surprising. However, the artificially controlled indoor climate in our buildings too often causes health problems, especially for those people who are susceptible to allergies and illness caused by unhealthy indoor air. Healthy housing addresses this problem by promoting homes that contribute to both the health of the environment and the people who live in them.

One of the basic building blocks of healthy housing is the use of solar energy. The sun is the greatest source of renewable energy available to us. It produces more than enough energy to heat all our homes. Solar energy is clean, non-polluting and readily available.

Using the sun to heat and light our homes is not a new idea. Today, we have a greater understanding of building science and a range of economical building products we can use to take advantage of the sun which were not dreamed of 30 years ago.

Passive solar design is a means to use energy from the sun to reduce the use of purchased energy while maintaining a comfortable, pleasing and healthy environment. Solar energy is not an alternative to other strategies, such as energy conservation and energy-efficient heating systems, but a complement to them.

Designing with sunlight creates brighter, more interesting interior spaces, with larger windows and solariums which are great selling features. However, careful attention to the principles of passive solar design is required to prevent overheating, excessive air conditioning, discomfort near glass and condensation on windows.

The challenge for passive solar designers is to incorporate design features without creating discomfort, using essentially conventional building materials. Good design tools are important. This is where CMHC's latest offering comes in. Tap the Sun: Passive Solar Techniques and Home Design is a thorough update of their Passive Solar House Design for Canada first published in 1989.

This book is designed to help make the best use the sun's energy in new homes. It is divided into three parts:

Part 1 is an overview of the basic elements of passive solar design. It includes a discussion of the solar resource, and how solar energy is collected, stored and distributed throughout the house for maximum comfort. Control of summer heat gains by using shading and ventilation strategies are important for successful solar design.

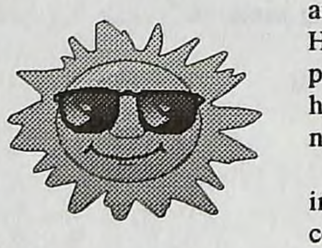
A passive solar home is subject to possible overheating. Although specifics may be subjective, the evidence is that temperatures 4°C above the normal heating season temperature will be uncomfortably warm for most people. October is usually the critical month for overheating. Part 2 shows how to integrate passive solar heating elements with other design considerations. How to evaluate passive solar designs using computer modeling is discussed along with site planning issues.

To help designers, software that provides guidelines to check a home design for excessive solar overheating in winter is included with the book. The *Comfort Design Checker* software is an easy-to-use spreadsheet, but does require Excel 5.0 to run.

Integrating the theory into a design is a major challenge. This book also includes 20 house designs that use the sun to reduce energy consumption. One unique feature is that the designs presented are not just theoretical. They were developed for specific Canadian cities, and most have been built in various parts of Canada. All have envelope characteristics that meet or surpass the requirements of the 1995 National Energy Code for Houses (NECH). While each design uses the sun's energy to provide heat, each also meets a variety of needs, desires and budgets.

This is an excellent solar design primer, full of useful information. Unfortunately, the artists who laid out the book got carried away with graphic design and forgot that numbers and text in charts and tables are meant to be read, not just looked at for their patterns. Most tables are not very legible, especially for the visually challenged. Even with my reading glasses, I had a hard time reading the information. Fortunately, the CD that comes with the book not only contains the software, but also includes the full text of the book, so through the magic of the computer zoom function you can blow up the view to make it readable.

The CD also provides healthy housing information, including the Internet address to CMHC's site.



Tap the sun: passive solar techniques and home designs
Accompanied by a CD-ROM. $ 39.95
Canada Mortgage and Housing Corporation.
1-800-668-2642

Energuide for Houses

Energuide is an energy labelling program that has been in effect in Canada for a number of years. However, contrary to perceptions, just because an appliance has an Energuide label, it does not automatically mean it is energy efficient. Rather, it provides a performance rating suitable for comparing different products in a class.

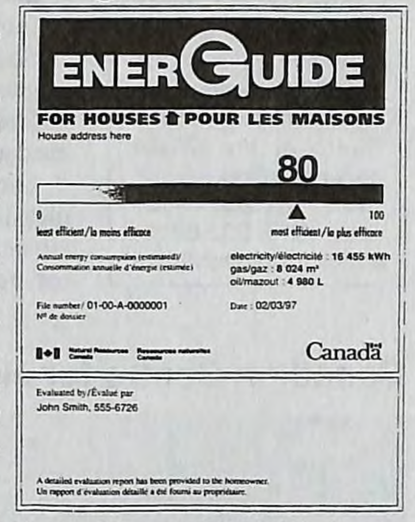
The Energuide labelling approach is now being extended to the housing sector. Unlike most appliances, which must be labelled, EnerGuide for Houses is a voluntary program.

Energuide for houses will provide residential energy efficiency audits to Canadian home owners. The program will be delivered through a strategic collaboration of governments, utilities, businesses, community and environmental associations. The ultimate goal of EnerGuide for Houses is to reduce green house gas emissions from the residential sector by encouraging energy consumption reduction. Home owners will receive unbiased, personalized information on potential home energy efficient improvements. EnerGuide is designed to help overcome the "not knowing where to begin" barrier often cited by consumers.

EnerGuide for Houses service providers will be responsible for recruiting and training energy assessors, administration and delivery, local quality control and marketing.

As part of the EnerGuide for Houses code of ethics, service providers must recommend that homeowners obtain competitive bids for renovation or energy improvements from contractors of their choice. This offers a strategic business opportunity for qualified renovators who may wish to work with service providers in their area.

The HOT2XP software for EnerGuide, based on HOT2000, has been developed for use by the Energuide for Houses program.



Typical Energuide Label for houses

For information: Jean-Yves Letang,
Manager, Energuide for Houses
Office of Energy Efficiency
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E-mail: jletang@nrcan.gc.ca

R-2000 Home Technical Requirements under review

The R-2000 Home Program has served as a catalyst for a broad range of changes in the home building industry since 1982. It has raised the ceiling for the construction quality and overall performance of every new home built in Canada. The program has provided a solid foundation of building science that allows builders to adopt new technologies, materials and products with confidence.

Although the program has been driven by energy efficiency concerns, it is now seen to be linked to improved comfort, a healthier lifestyle and broad environmental benefits. Cost savings due to reduced energy use are a bonus.

To remain current, the R-2000 technical requirements are reviewed every few years. The last review was done in 1994. Since then, changes have taken place in the residential construction industry, some of which could affect the R-2000 Program's position at the leading-edge of mainstream housing technology. That is why a technical review of the technical standard is presently underway.

The technical requirements have to perform a delicate balancing act. If they are too rigorous, the number of R-2000 houses being built will diminish. If they are too loose, enrolments may increase but the critical leading-edge element will be lost. Finding the proper balance between these two conflicting needs is the key to success.

Those closest to the action, the R-2000 partners and homebuilders, often have the clearest understanding of the strengths and weaknesses of the R-2000 Program. Thus, the review process of the Technical requirements is being designed to be as open as possible with an emphasis on participation from the R-2000 partners and homebuilders.

The basis of the R-2000 technical standard will continue to be:

- energy efficiency in new housing;
- improved housing systems; and
- technical and professional excellence.

The standard should help distinguish R-2000 builders in the marketplace. It should help provide a marketing advantage for participating builders. There could easily be no changes recommended.

Some Issues That Have Already Been Raised:

Should the incremental cost of R-2000 construction be allowed to increase as the result of changes to the Technical Requirements?

For information on the R-2000 Program, contact your local program office, or call
1-800-387-2000

Readers are invited to send any comments they may have on the R-2000 Program technical standards to Gary Sharp at the CHBA national office:
Tel: (613) 230-3060
Fax: (613) 232-8214
e-mail: chba@chba.ca

Should the R-2000 compliance process be simplified?

Should there be more flexibility in the energy targets?

Should the Technical Requirements be shortened and simplified?

Should the current pick-lists be regional? The pick-lists that are presently used to select indoor air quality and environmental/eco management options were developed at a national level and may or may not reflect what is most appropriate, or even commercially available, in specific regions.

Should the R-2000 Program expand into larger, multi-family housing?

The scope of the R-2000 Program is currently restricted to those buildings that fall under Part 9 of the National Building Code of Canada.

Are there other areas that the R-2000 technical requirements should address?

Canadian Centre for Housing Technology

First two test houses at the Canadian Centre for Housing Technology under construction

Since the 1950s, advances in housing design, construction, materials and building practices have helped Canada create quality, affordable housing that is well suited to our demanding climate.

Maintaining an innovative spirit is crucial to ensuring that technology remains effective in the face of changing social, economic and environmental pressures.

To maintain our position at the leading edge of building science, a new housing technology research centre at the National Research Council in Ottawa has been created. The new centre, called the Canadian Centre for Housing Technology (CCHT), is a joint initiative of the National Research Council, Canada Mortgage and Housing Corporation, and Natural Resources Canada. The first phase consists of two research houses that will serve as laboratories for testing energy consumption, indoor air quality and overall building performance.

The Centre is the only research facility of its kind in the world. It is dedicated to accelerating the development and acceptance of new technologies for the housing industry - and to supporting market opportunities for Canadian housing products and services. Founded on the premise that "the house is a system," the Centre will use its houses to research, evaluate and show the impact of innovative products and alternate construction techniques on total house performance.

The facility will also ensure that findings are shown to industry to help produce more affordable, efficient and sustainable housing.

The first phase of the Centre consists of a reference house and a test house, and an information display-and-demonstration building.

The reference and test houses are side-by-side and identical in orientation, size and construction. Both are being built to R-2000 specifications and Healthy Housing principles to establish a "best practices" example of current construction. Regular crews and standard construction practices are being used on the site. Minto Developments Inc. of Ottawa, a major builder developer in the capital region, won the contract to build the two houses. The design used is one of Minto's most popular models.

To establish background information, both houses will be monitored under identical simulated operating conditions for the first year (completion is scheduled for late November 1998).

Both houses use automated controls to simulate human occupancy and sophisticated computer equipment for gathering data. Construction and operating costs, energy consumption, construction waste, comfort conditions, and indoor air quality will be fully documented for both houses.

The reference house will serve as a control unit, while the test house can be modified according to specific research requirements. Features such as windows, heating systems, ductwork, and controls can be altered or replaced, allowing for an assessment of their effect on house performance. The reference house will be able to be down-graded to lower performance levels when required for specific research projects.

A unique feature of the centre is that the houses are full-scale, and not the test huts typical of most research centres. As a result, the impact of a building system can be tested on the entire house rather than just on part of it, the results of which would then have to be extrapolated to a full house. It will also make it easier to test subsystems such as full mechanical systems.

Unlike other demonstration houses that are tested and monitored for a short period and then turned over to home buyers, these houses will never be lived in. As a result, researchers will have unlimited access to the buildings, and will not have to be too fussy about the finishes and potential disruption of residents' life style.

An information centre is also being built. The CCHT Info Centre is a customized three-unit row house, displaying the adaptability of residential construction to light commercial, multi-unit housing, and mixed uses. Two of the units have been combined to provide offices, meeting rooms and a 1,600 sq. ft. presentation and display space. A separate information centre is being built because the houses themselves will not be open to the public. The large number of visitors expected would upset the monitoring of the performance under simulated occupancy conditions. All the information, including construction mock-ups, will be on display at the Info Centre which stands across the street from the test houses.

The third row house is a furnished demonstration of a nationalcompetition-winning FlexHousing design, demonstrating a practical approach to layout and construction, with the ability to be adapted and converted, or expanded as the needs of its occupants change.

The basement of the Info Centre itself will feature three innovative concrete technologies. The exterior foundation walls are the first-ever house-sized pour of a self-levelling, high-performance concrete mix. The interior basement walls are a high-volume fly ash concrete, using recycled fly ash that is a waste from coal-fired electricity-generating stations. The basement floor features electrically conductive concrete, a first-time application of this technology in a real building.

Four additional serviced building lots are available for assessing and demonstrating alternate house construction technologies. These additional research houses will be used to study other innovative construction processes or components, such as an insulated-concrete formwork house, an energy-efficient steel-framed house, or an advanced "dark green" house featuring super energy efficiency and renewable energy products. Any of these future houses will be built to the same house design. However, no specific plans have been made yet.

Several research projects with industry partners are already being developed, including performance evaluation of advanced mechanical systems combining efficient heating, cooling, ventilation, water-heating, and distribution. ☼

For information:
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CCHT Project Manager
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e.mail: tim.mayo@nrc.ca

Global Warming and Housing

Our industrial lifestyle is causing global climate changes. Many of these changes are the direct result of gas emissions into the atmosphere.

In Kyoto, Japan, participating countries agreed to a timetable to limit emissions. The Kyoto target applies to the six most important greenhouse gases. Carbon dioxide accounts for 80% of greenhouse gas emissions and its reduction is considered the main solution to limiting climate change. However, it is also important to reduce the emissions of gases such as methane and nitrous oxide.

Meeting the Kyoto challenge will not be easy. The intent of the international effort is to reduce emissions below 1990 levels by between 2008 and 2012. The European Union committed to reducing emissions by 8%, the United States by 7% and Canada and Japan by 6% each.

Carbon dioxide emissions can be reduced in two ways: by improving energy efficiency and by switching to energy sources that contain less carbon. In Canada, about 80% of total carbon dioxide emissions are a result of secondary energy use, that is, by agricultural, residential, commercial, industrial and transportation sectors, and through generating electricity to meet this energy demand.

Canadians spend more than $75 billion per year on secondary energy to heat and cool homes and offices and to operate appliances, cars and factories. This represents about 10% of our gross domestic product (GDP).

Residential Energy Use

Because of improvements in energy efficiency,

the growth in residential energy use is not as large as population and economic activity would suggest. Energy use has increased 12% since 1990, but it is estimated that, without the energy efficiency improvements, it would have grown by 19%. However, carbon dioxide emissions rose by only 6%. This increase was less than the increase in energy use due to a decrease in the carbon intensity of residential energy sources.

Here are some key considerations for increased energy savings by 2010 in the residential sector:

- Heating now accounts for 60% of residential energy use.
- Houses last a long time. By the year 2010, houses built after 1995 will only account for 21% of the total housing stock. Retrofit of existing older housing is going to be important.
- Most equipment has a life span of 20 years or less. By 2010, many energy users will have replaced much of the early 1990s equipment with new, more efficient appliances developed as a result of energy efficiency initiatives in the 1990s.

It is important to keep in mind that no matter how efficient a heating appliance is, it is still better to reduce the amount of heat the appliance is required to produce. That means taking advantage of all the passive means available, such as more efficient building envelopes and optimizing solar gains. Pressure for improvements in the building envelope will be with us for some time. ☼

Letters to the Editor

Re:Pilot Light Fuel Consumption

In the July 1998 issue (Solplan Review No. 81) Rob Dumont proposed banning water tank pilot lights. I do not believe this action, by itself, would be as effective as it might first appear. In a standard water tank the major energy loss is through the uninsulated, central flue; the flue can't be insulated as it is required to transfer heat into the water. The pilot energy balances the flue losses at least partially and perhaps totally.

I recently tested an after-market flue damper proposed for residential domestic water heaters. During the testing I checked the stand-by operation of two water heaters. The tanks were brought up to temperature, cycled once by drawing off some water then allowed to 'stand-by' for a period. In both cases the tank's main burner did not cycle on during the standby test; one test was 65 hours in length and the other was 40 hours.

The pilot inputs were in the order of 500 Btu/h, so the flue losses were probably 400 Btu/h, assuming 80% efficiency. Without the contribution of the pilot the main burner would have to cycle on to make up for this loss.

Perhaps elimination of the pilot and a combination flue and vent damper with a sensor to prevent burner operation unless the dampers were open would be effective in reducing the standby losses. The dampers would have to fail open in case of power failure to allow the unpowered operation provided by current water heaters. A flue damper would prevent the loss of heat from the water heater and the vent damper would prevent the loss of warm air from the treated space.

A mid-efficiency domestic water heater similar to a mid-efficiency furnace would also cut into the standby losses but would not be operable during a power failure. The same restriction would apply to the use of a high efficiency water heater.

The economics of adding much in the way of complication to a water heater is questionable when they typically consume 20 to 30 GJ/year ($100 to $150 per year) and operate at an energy factor of 55%.

The useful load at 20 GJ/year input is 11 GJ. A complete elimination of the flue losses could bring the energy factor up to 80%, requiring a consumption of only 14 GJ/year ($68/year) for a $32/year saving. Any design modification would have to cost less than $160 to achieve a simple payback of 5 years. Such an improvement would have to be mandated or marketed very cleverly as the first cost is considered to be the deciding factor in most water heater purchases.

In the same article you suggest that 1/3 of Canada's energy is used in each of three categories: buildings, transportation and industry. I am not sure how this fits with the statement by CGA in its Climate Change Chronicles which says that the Canadian green house gas contribution by sector is

Transportation (road, rail air)	26%
Electricity	17%
Industrial	16%
Fossil fuel production	16%
Non-energy (agricultural?)	12%
Residential	8%
Commercial	5%

(I am not aware of where multi-family residential is listed)

Gordon Bryce, Sr. Eng.
Customer Safety, BC Gas

Rob Dumont replies:

1. Water heaters

The major problem with water heaters is poor insulation. I did a check a standard (33 Imp. gal.) electric tank, and found that the standby loss with the water temperature at 50°C was about 100 watts (341 Btu/hr). By insulating the tank from its original level of about R4 (one inch of insulation) to about R20 I could reduce the standby losses to about 25 watts (85 Btu/hr). If the tanks came with this higher level of insulation (I believe that in California the minimum insulation level for commercial water tanks is R16) then the heat gain from the pilot light would be unnecessary.

In the United States they market a heat-activated bimetallic vent damper that needs no electricity to function.

With a combination of the vent damper, spark ignition, and better insulation, the efficiency of water heaters could be substantially improved. In volume production, the cost increase could likely meet your five-year payback criterion.

2. Canada's Secondary Energy Demand.

A report from the Economic Council of Canada (Connections, An Energy Strategy for the Future, 1985) presents figures for the Secondary Energy Demand in this country as follows:

Residential & Commercial Buildings	*38.6%*
Transportation	*26.7%*
Industrial	*34.7%*

Thus I think it is fair to say that roughly ⅓ of the energy in Canada is used in each of the Buildings, Transportation and Industrial Sectors. The energy supply industries also use energy, as you have noted, but if there were no final demand for these products, there would be no need for the energy supply industries. The CGA numbers you presented likely do not include hydroelectricity, which supplies about 27% of the energy in the country, according to the Economic Council of Canada report.

3. Energy Prices

A major problem with current energy prices is that they do not reflect externalities. With fossil fuels, the release of methane gas and the production of carbon dioxide are major problems. Methane releases alone now account for about 20% of the total greenhouse gas problem. (Carbon dioxide is responsible for about 72% and nitrous oxide for the remaining 8%). It is true that current natural gas prices are low. However, if a carbon tax were applied as is now the case in Sweden, the price of natural gas and other fossil fuels would more closely reflect their true cost to the environment. ☼

After reading Rob Dumont's column in the July issue (Solplan Review No. 82), I realize that the Kyoto treaty imposes a drastic penalty upon countries whose population is growing rapidly. Rob says that Canada has averaged population growth of 1.8% per year since 1941. If Canada's total CO_2 production has gone up 'only' 13%, then CO_2 production per capita may have declined slightly, because the population has probably grown by more than 13%.

A few countries, including Italy and Germany, now have a declining population. Their total CO_2 emissions will decrease even if they do nothing to improve energy efficiency and introduce use of renewable energy. I think that this is unfair to Canada and over generous to Germany.

The Lovins' book Factor Four has useful information showing how different countries compare. In Rob's terms, North American buildings do better than German or UK buildings on a technology basis, but the level of energy consumption outweighs this advantage.

Take UK houses, for example. They are smaller than Canadian houses and not as warm inside. Thanks to the Gulf Stream, our winters are mild even while being on the same latitude as Hudson's Bay or Labrador. So there is less CO_2 production this side of the Atlantic. However, if there was a like-for-like comparison, heating a UK house would produce more CO_2 than heating a Canadian one.

As I look abroad to Ireland, France, Belgium and the Netherlands, there is a huge scope for improvement in the construction quality of temperate climate houses compared with cold climate houses. Technology may be relatively painless and offers us cheap CO_2 savings while changes in consumption, such as smaller houses, may be resisted.

David Olivier
Herefordshire, England

In his article "An Ideal Mechanical Ventilation System for Houses" (Solplan Review No. 82, Sept. 1998) John Haysom forgot an important factor: COST. A ventilation system must be affordable. To be affordable, you need to consider both the up-front, installed cost, and the operating cost. As a rule, a system with a lower up-front cost will often have a higher operating cost, and vice versa. So costs are a balancing act.

While the article states that "An ideal system

Continued on page 16

Energy Answers

Rob Dumont

What is FACTOR 10?

At the Green Building Challenge Conference in Vancouver in October this year, many Europeans mentioned this challenging idea for sustainability.

FACTOR 10 refers to a 10-fold reduction in the rate of pollution from the goods we consume. Thus a FACTOR 10 house would be one that used only 10% as much energy as conventional houses. A FACTOR 10 car would get about 250 miles per gallon.

Why the number 10?

The argument goes as follows: In rough terms, a sustainable world will have to reduce its rate of pollution of the earth's environment by at least a factor of two. At the same time, world population is expected to double from its current level of six billion, and the consumption rate of goods of the average citizen of the world will likely increase about three times. If you do the math, the only way that the earth will be sustainable is by radically reducing the amount of pollution per unit of consumption. In other words, a 10 or 12-fold reduction in the pollution for each unit of consumption is needed. It is "FACTOR 10 or Bust."

Can the earth's people pull it off?

Unfortunately, most of the current debate seems to be dealing with about FACTOR 0.05, or about 200 times too little. For instance, the Kyoto Summit is calling on most industrialized countries to reduce their carbon dioxide production about 5% or 6% compared with 1990.

What would a FACTOR 10 energy source likely be?

FACTOR 10 energy sources will have to be solar-based. Fortunately the sun's energy striking the earth is roughly 10,000 times the current rate of our use of fossil fuel energy.

Do we have any FACTOR 10 buildings here in Canada?

I like to think that the house I live in is a very good energy citizen, using only a small fraction of the energy used by conventional houses. The house has hyper-insulation (R80 attic, R60 walls, R35 basement floor), passive solar gains through excellent windows, an envelope three times tighter than the R-2000 standard, a high efficiency air to air heat exchanger, an active solar system with 168 square feet of panels and an oversized storage tank, low energy appliances and lighting. However, when I do the math, it is only about a FACTOR 6 house in this climate compared with conventional houses.

If our house were moved to a warmer part of Canada such as Vancouver, however, it likely would be a FACTOR 10 house.

This FACTOR 10 approach is pretty rad. What are some technology steps that need to be done to make FACTOR 10 a reality?

Here are a few thoughts on what might be done in the residential sector.

Most of Canada's recent demonstration houses such as the Advanced Houses have been roughly FACTOR 4 in performance. The R-2000 houses are roughly FACTOR 2 or 3. I would propose that we have to move to a deeper green and build some FACTOR 10 or FACTOR 20 houses. This approach is way ahead of the marketplace, and is akin to investments in science such as astronomy or space research. The role of government is obvious.

Such projects are worthy of a millennium endeavour. The earth is little more than a large spaceship, and the envelope of the spaceship is being badly damaged by our current environmental and energy use practices. It really is "FACTOR 10 or bust." ☼

Continued from page 15

with a full array of sensors is not attainable..." such a system may not even be desirable if it is not affordable. The cost of a variety of controls can easily be more than can be justified by a slightly lower operating cost.

Therefore I suggest that, instead of "demand controlled" being an ideal characteristic, an ideal ventilation system should be "cost effective." If the cost of exotic controls can be justified by much lower operating costs then, by all means, install then. If not, then install a simple control—or perhaps no control. A system that is hot-wired to run continuously may be ideal in many instances. The bottom line: run a few calculations and see what can be economically justified for each project.

John Bower, The Healthy House Institute
Bloomington, IN

Conformity Assessment to Air Barrier System and Air Barrier Material Requirements of the NBC

NRC·CNRC

By B. Di Lenardo

The National Building Code of Canada (NBC) requires that an 'effective' air barrier system be incorporated within the building envelope. Although the NBC addresses the performance characteristics to be considered to show that an effective air barrier system has been achieved the NBC does not prescribe any specific test protocols with acceptance criteria to verify compliance of proprietary air barrier 'systems' nor a procedure for air barrier 'materials'. The Canadian Construction Materials Centre (CCMC) has developed a test protocol for the evaluation of proprietary air barrier 'systems' and air barrier 'materials' according to the intent of the NBC.

The CCMC evaluations of an air barrier 'system' or an air barrier 'material' focus on the five main principal requirements of any air barrier system, specifically that an air barrier system must:

- Have an acceptable air leakage rate;
- Be continuous throughout the building envelope;
- Withstand structural wind loading expected during its service life;
- Be durable; and
- Be buildable or reproducible in the field

Evaluation of Air Barrier Materials

Consistent with the first principle listed above, the NBC specifies that the 'material' that provides the principal resistance to air leakage within the air barrier system is required to have an average leakage characteristic not greater than 0.02 L/(s·m^2) at 75 Pascals (Pa) pressure difference. (This represents the leakage rate, for example, through a 12.7-mm sheet of unpainted gypsum wallboard.) Part 9 does not currently contain quantitative requirements for maximum allowable air leakage rate of either an air barrier system or the materials used to form it. It provides a list of materials considered to have low air permeability, all of which have air leakage characteristics that are 0.02 L/(s·m^2) at 75 Pa or less, as required in Part 5.

The CCMC evaluation of an air barrier 'material' involves testing no less that five 1 m^2 specimens though a range of air pressures following a carefully prescribed procedure. The data is then plotted and the air leakage rate @ 75 Pa is derived from the linear regression of the data points. This air leakage rate value must not exceed the 0.02 L/(s·m^2) which is then published in a CCMC Evaluation Report for the proprietary air barrier 'material'. CCMC also confirms that the material conforms to its respective product standard to ensure durability of the material.

(At the request of industry, this CCMC protocol is presently being incorporated into a CGSB standard.)

The NBC specifies that the air barrier system must also be continuous across construction joints, control and expansion joints, at penetrations through an assembly, and at junctions with other assemblies. To address these NBC requirements, CCMC requires that the proponent of the air barrier 'material' define their proprietary air barrier 'system' to be constructed in the field. An appendix to the CCMC Evaluation Report contains a summary of the proponent's 'system' which has not been evaluated by CCMC.

The CCMC Evaluation Report clearly states that the building official must determine whether they accept the system details as forming an 'effective' air barrier system for their jurisdiction. As the structural integrity of the fasteners and the joints of the system has not been tested, the system may be acceptable in urban, low wind or sheltered areas while it may not be acceptable in exposed or high wind areas. Thus, the CCMC Evaluation Report for an air barrier 'material' may not result in product acceptance throughout all regions in Canada.

Evaluation of Air Barrier Systems

The code committee responsible for air barrier system requirements recognized that, ideally, the maximum air leakage rate of the air barrier system (including materials and joints) should be specified. To help designers, the Appendix to Part 5 of the 1995 NBC provides a list of recommended maximum air leakage rates for the air barrier system suitable for most climates in Canada. During the development of the CCMC test protocol and evaluation criteria for air barrier systems these 'recommended' air leakage rates were revisited.

Complex mathematical modelling was undertaken for various wall types varying the air barrier properties, location of the air barrier and varying properties of the other wall components. The climates of Edmonton, Halifax and Ottawa were simulated for temperature, wind pressure, wind direction and vapour pressure. A new permissible air leakage rate for the air barrier 'system' was established as follows:

Water Vapour Permeance (WVP) of Outermost (Non-Vented) Layer of Wall Assembly ng/(Pa·s·m²)	Maximum Permissible Air Leakage Rates L/(s·m²) at 75 Pa
15 < WVP < 60	0.05
60 < WVP < 170	0.10
170 < WVP < 800	0.15
> 800	0.20

This table is different from the table in the Part 5 Appendix and forms the basis of CCMC's evaluation criteria for an air barrier system.

To qualify, a minimum of three full-scale (i.e., 2.4 m x 2.4 m) wall specimens must be tested. One specimen must represent the air barrier system within the opaque insulated portion of the wall while the second and third specimens, to verify continuity, contain penetrations and joints (i.e., window, pipe, duct, concrete sill, etc.). These joints must be sealed by the accessories as part of the proprietary air barrier system. Before these specimens are measured for air leakage, they are structurally "aged" to represent the structural wind loading to be experienced by the air barrier system in the field over an extended period. The structural wind loading consists of one-hour sustained loads, 2000 cyclic loads and one gust wind load.

After structural loading the air leakage of the three specimens through a range of pressure differentials is measured. The air leakage rate of the system is assigned based on a criteria accounting for the variability between the specimens built in a fashion similar to the field situation.

The CCMC evaluation also includes a durability assessment of the air barrier system materials and accessories. The materials forming the principal plane of airtightness must be capable of maintaining their strength and air permeance properties after aging.

A successful evaluation of an air barrier system is published in a CCMC Evaluation Report containing a detailed description of all the salient features making up the conforming proprietary air barrier system.

For more information on the development of the CCMC test protocol and evaluation criteria IRC has published a new publication entitled, Air Barrier Systems for Walls of Low-Rise Buildings: Performance and Assessment. The publication also discusses the intent of the NBC requirements and the relationship between the vapour barrier and air barrier. For CCMC evaluations of air barrier materials (2 published) and air barrier systems (1 soon to be published) please consult the Registry of Product Evaluations available through IRC's clients services at 1-800-672-7900.

Bruno Di Lenardo is an evaluation officer with the Canadian Construction Materials Centre (CCMC) of NRC's Institute for Research in Construction.

Electrically Conductive Concrete

Conductive concrete is a cement-based composite that contains a certain amount of electrically conductive components to attain stable and relatively high conductivity. When electricity is applied, the resistance generates heat.

Electrically conductive concrete has the potential for use in many important applications, including: cathodic protection of reinforcement in concrete structures, electric heating for de-icing structures like bridges and roads, electrical grounding, electromagnetic shielding, and space heating of buildings.

Electrical heating using conductive concrete has excellent potential for domestic and outdoor environments, especially for de-icing of parking garages, sidewalks, driveways, bridges and airport runways. This could reduce or eliminate the need to use de-icing salts. However, the overall environmental impact would need to consider the source of the electric power being used.

Characteristics of High-Performance Conductive Concrete:

- Combines high conductivity with mechanical strength.
- Stable conductivity value. The effect of moisture content is insignificant.
- Light weight: the density is about 70% that of normal concrete.
- Chemically compatible with normal concrete. Conductive concrete can be used as a topping for conventional concrete.
- Thermal stability is comparable to that of normal concrete.

Carbon and steel conductive fibres can be used as the conductors and reinforcement, depending on the electrical and mechanical properties required of the concrete. However, it appears that using metallurgical coke breeze with an optimal size is a more cost effective conductive aggregate.

According to laboratory results, the surface temperature of concrete can be maintained above the freezing point at an air temperature of about -30°C, when the electric power output reaches 812 W/m². (75 w/sq.ft.)

The temperature distribution over the concrete is relatively constant so there is no thermal stress.

Electrically conductive concrete was developed at the National Research Council's Institute for Research in Construction. A test section is being installed in the basement floor of the information centre of the Canadian Centre for Housing Technology where it will be monitored when used as a space heating element for the building.

Coming Events

December 2-4, 1998
Homebuilder Expo
Toronto, ON
Fax: 416-504-8262
www.constructcanada.com

January 15-18, 1999
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Fax: 905-954-0732

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greenprints@southface.org

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www.esv.or.at/esv/
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